DOCUMENT RESUME

ED 119 969 SE 020 289

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TITLE Management Science/Industrial Engineering Techniques to Reduce Food Costs.
PUB DATE Jun 75
NOTE 10p.; Paper presented at the Annual Meeting of the American Society for Engineering Education (Colorado State University, Ft. Collins, Colorado, June 16-19, 1975)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage
DESCRIPTORS Costs; *Economic Factors; Engineering; *Food; Manpower Utilization; *Operations Research; *Productivity; *Questionnaires; Research Methodology; Surveys
IDENTIFIERS *Food Processing Industry

ABSTRACT

This paper examines the contributions of Industrial Engineering and Management Science toward reduction in the cost of production and distribution of food. Food processing firms were requested to respond to a questionnaire which asked for examples of their use of various operations research tools and information on the number of operations research people employed by them. Replies came only from large firms--with sales volume above $300 million annually. Another questionnaire, addressed to Directors of Industrial Engineering in food related companies, yielded responses from businesses with annual sales ranging from $85 million to $2.4 billion. Results of the questionnaire show a variety of approaches are being utilized in attacking the problems associated with food costs and availability. Although most of the work cited has been done by large businesses, the basic principles and techniques of methods improvement, work simplification, cost reduction and logical methods of problem analysis and development of solutions are applicable to small businesses as well. (BT)

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ED119969

Event Number: 4510
American Society for Engineering Education
83rd Annual Conference
June 16-19, 1975
Colorado State University
Ft. Collins, Colorado 80523

Title of Paper:

Management Science/Industrial Engineering Techniques to Reduce Food Costs

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SE 020 289

M.S./I.E. Techniques to Reduce Food Costs

We are all concerned over the rising cost of food that we buy, and most of us wonder what, if anything, has been done to counteract the trend toward further increases. I have writren to many individuals and organizations in an effort to gather information regarding Industrial Engineering and Management Science contributions toward reduction in the cost of production and distribution of food. One of the most succinct replies came from Mr. A. I. Morgan, Jr., Director, Western Regional Research Laboratory, U.S.D.A. Agricultural Research Service, in Berkeley, California:

> To answer your question about contributions of I.E. to food production and distribution, I suppose I would say that the American system, at least, is pervaded by examples of the application of I.E. principles (e.g., quality control, motion study,... optimization, etc.). Whether these principles have always been consciously recognized as I.E. principles, I cannot say, but at any rate they are there.
>
> To cite a few examples, consider the formulation of least-cost rations for animal feeding by linear programming or by some other means of optimization within constraints, the virtually complete automation of poultry and egg production, modern milking facilities, water management in food processing plants, the modern feed lot or fresh produce packing shed, and so on. Perhaps the supermarket itself would qualify as an example (1).

Eleven large food processing firms provided information describing, in brief, their application of Management Science techniques. Responses were directed toward a questionnaire in which I asked for examples of their use of various operations research tools and information on the number of O.R. people employed by them, among other items. Although I wrote to a number of firms ranging in size from the giants of the U.S. food industry to relatively small concerns, it did not surprise me to find that the replies came only from large firms -- with sales volume above $300 million annually. This is probably an indication of the fact that smaller industrial outfits do not tend to employ people as OR/MS specialists. The respondents ranged in size from about $350 million to over $2.4 billion in annual sales, and the number of OR personnel employed ranged from zero to 30. Following is a brief summary of reported applications:

Linear Programming: Determining warehouse location; factory location; handling "myriad truck and rail problems;" service area assignment to warehouses; product allocation to plants; least-costing animal feed formulas; production planning; media planning.

Network models: Distribution; communications systems.

PERT/CPM: Building construction; new product introduction and development.

Dynamic Programming: Plant site study.

Integer Programming: none

Non-linear Programming: location of warehouses.

Game Theory: Pricing.

Queueing Theory: Plant queues.

Simulation: Venture analysis; warehouse location; simulation of proposed production operations; warehouse storage capacity requirements and safety stock studies; inventory planning; national distribution study; plant optimization.

Other techniques mentioned included:

Financial modelling; statistical forecasting; use of simple accounting models; development of various information and reporting systems together with statistical analysis; decision theory; adaptive forecasting (short-range); multiple regression for forecasting and promotion evaluation; long-range planning.

Another questionnaire, addressed to Directors of Industrial Engineering in food-related companies, yielded responses from businesses with annual sales ranging from $85 million to $2.4 billion. Again, none could be classified as "small businesses". The number of Industrial Engineers employed ranged from none* to 50. Reported I.E. activities included the following:

Plant layout: major automation and remodeling of corn processing plants; improvement of palletizing and conveying systems, and packaging operations; cereal plant design; layout of a new plant plus addition of a product line in an existing plant; packaging line relayout to increase productivity, and design of new plant layout to function with minimum manpower.

* other engineering specialists handled I.E. functions.

Methods improvement, job design: change in method of bulk glass container receipt to increase the number of packages received per pallet, and reduce manpower and equipment lag time; reduction of manpower requirement for packaging operations, and decrease in scrap produced in candy moulding line; improved work station layout for corn-on-cob baggers and inspectors; study of warehouse and bagging operations to permit decision on automated palletizer installation.

Work measurement, incentives: restructure of incentives used in field operations; piece rates for product packers; standards development for labor and material usage.

Production planning and control: coordination of new packaging and process innovations to meet market requirements and assist in old package phase-out; provision of standards for computer data base used in production control system; linear programming for scheduling a vegetable drying plant; evaluation of harvesting schedules, processing capability, etc., with a view toward maximization of capacity and optimization of cost; frequent updating of yearly forecast of plant production requirements.

Quality control: improvement in adherence to label weights as key to product profitabiltiy; preparation of new Q.C. specifications.

Management control system design: installation of Management Information System for production and maintenance operations; provision of manning, cost and efficiency monitoring systems for upper and middle management use.

Human factors studies: integrated in design of new operations; design of inspection workplace with varied lighting arrangements to provide ideal work stations for local and migrant labor; noise control; study of jobs historically performed by females to assure that they are properly rated in relation to "male" jobs.

The following cost reduction projects were mentioned:

Combining elements of a corn-on-cob processing system to reduce labor cost; improvement in productivity and saving in use of materials; optimization of juice-press cycle by balancing juice production and cycle time; I.E. coordination of package research, engineering maintenance, quality control and outside contractors to design new packaging method yielding cost improvement; reclamation of boiler exhaust gases for a drying operation, with resulting 15% drop in fuel requirement.

The respondents also emphasized the following I.E.-related activities as being most important within the next five years:

Use of Management information and control systems; value analysis; improvement in productivity, material and energy usage; the promulgation of I.E. techniques by general management; computer-oriented scheduling techniques applied to distribution; and, always, cost reduction.

In November, 1972, the Food Processing Task Force on Food Industry Productivity submitted a report on "Food Processing Productivity" to the National

Commission on Productivity, Washington, D. C. (2). The attempt was made to analyze the total food system in an effort to improve its productivity. One important conclusion was that there was a large potential for saving in the transportation area of the food marketing bill. At that time, it was noted that $6 billion was spent annually for transportation in the food system--$2 billion from farm to food processing and $4 billion from processing to retailing. Suggestions were made for improvement in car turn-around time, heavier loading, higher average shipment weights, unit-sized loads and orders, and "off-season" shipping. It was also found that packaging costs were high ($8.9 billion), indicating another area for potential savings through use of larger size packages and reduction in packaging and shipping requirements.

"Distribution '75: Where the Savings Are", (3) a special report by D. S. Malm and J. L. Fergusson, described savings potential in the areas of improved warehouse efficiency, reduction in energy requirements, bypasses to major distribution cost factors, and improved systems management methods. All of the approaches mentioned represent concepts which can easily be grasped and applied by the Industrial Engineer or Management Scientist because they are consonant with his educational development.

Another facet of the food production-distribution picture, in which significant savings are being sought, relates to the reduction of food losses due to spoilage and attack by insects and other pests. It is estimated that pests cause an annual loss of 30 percent in the potential worldwide production of crops, livestock, and forests (4). Progress has been made in the effort to develop improved packaging, featuring moisture barrier protection, completely

sealed and insect-resistant treated bags to protect food donated under the U.S. Food For Peace program (5,6,7). Such measures will help to achieve the dual benefits of increasing the supply of food for the hungry world, as well as reducing the cost resulting from losses.

The potential for savings in distribution costs has led to the currently intense activity in the installation of "point of sale" supermarket checkout systems, using laser scanners to read "Universal Product Code" labels printed on packaged food items (8). Test installations are now being evaluated by various supermarket operators, for their potential in reducing checkout and packing labor costs, and in permitting increased throughput at supermarket checkout stands (9).

In conclusion, we have seen examples of the variety of approaches that are being utilized in attacking the problems associated with food costs and availability. Although most of the work cited has been done by Industrial Engineers and Management Scientists employed by large businesses, the basic principles and techniques of methods improvement, work simplification, cost reduction, and logical methods of problem analysis and development of solutions, are applicable to small businesses as well.

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